Statistical Science
2020, Vol. 35, No. 4, 663–671
https://doi.org/10.1214/19-STS766

A Conversation with J. Stuart (Stu) Hunter

Richard D. De Veaux

Abstract. J. Stuart (Stu) Hunter has been an inspiration and mentor to a generation of statisticians, especially to those working in industry. Born on June 3, 1923 in Holyoke, Massachusetts, Stu moved to Linden, New Jersey at the age of 2 where he spent the rest of his childhood, graduating from high school at age 16. After receiving a bachelor's degree in Electrical Engineering in 1947, he went on to receive a master's degree in applied mathematics in 1949 and a PhD in statistics in 1954, all from North Carolina State. His research centered on experimental design, in particular the study of fractional factorial designs and response surface methods. He was the founding editor of *Technometrics*. Stu joined the faculty at Princeton University as an assistant professor in the Engineering School in 1961. He was a first-rate teacher, and his courses at Princeton were often rated among the top courses at the University. The interviewer had the good fortune to take his Engineering Statistics course in 1970 which began a life-long friendship. Stu was a consultant for many companies and the co-author of the influential book *Statistics for Experimenters* with George Box and William Hunter. His short courses in industry were legendary. He served as the 1993 president of the American Statistical Association (ASA) and has received many honors and awards from the ASA, the ASQ and other organizations. In 2005, he was named as a fellow to the National Academy of Engineering. The Stu Hunter Research Conference was established in 2012 to "honor one of the pioneers in applied statistics." Stu retired from Princeton in 1984, but remains active consulting, mentoring and traveling to this day.

Key words and phrases: Experimental design, fractional factorial design, applied statistics, engineering statistics.

RDD: I'm here[1] with Stu Hunter who's about to celebrate his 96th birthday this Sunday in Princeton (New Jersey). Thanks so much for doing this Stu. I would first like to thank you for your inspiring courses and your support and encouragement all these years.

1. CHILDHOOD

RDD: So, Stu, tell me a bit about your childhood. Where did you grow up?

Stu: Well, I was born in Holyoke, Massachusetts, but when I was two my Dad took a job at the Elizabeth Daily Journal in Elizabeth, New Jersey. We lived in nearby Linden for most of my childhood. Both sides of my family were from Scotland: one—direct from the textile mills of Glasgow; the other—farmers who came to the United States via Canada. My grandfather owned a printing company that printed the local newspaper in Holyoke.

RDD: I grew up nearby in the early 50s, and most people can't imagine how rural New Jersey was then. I imagine it was even more rural in your childhood.

Stu: Oh yes. In fact, when I was 14, I got a summer job at a local dairy farm in Cranford that was biking distance from Linden. They mostly had me pulling weeds, but because that was before milking machines became widespread, I learned how to milk cows by hand.

Jean Hunter [Stu's daughter]: I can verify that! The rest of the family heard that story a couple of years ago, when he visited the Cornell vet school open house and showed them that 80 years after he had milked his last cow as a teenager, he still remembered how!

RDD: I also heard from Jean that you have a favorite story from childhood about glasses.

Richard D. De Veaux is the chair of the Department of Mathematics and Statistics and C. Carlilse and M. Tippit Professor of Statistics, Williams College, Williamstown, Massachusetts 01267, USA (e-mail: rdeveaux@williams.edu).

[1]Recorded driving between Newark Airport and Princeton, New Jersey in a car driven by Jean Hunter.

FIG. 1. *Stu* (*standing behind*) *with his father and siblings in the early* 1930*s*.

Stu: Yes, I had always thought that gardens were just full of smudges of color. I had gone to the doctor for a routine visit and he fit me with glasses. When I came out, I was astounded that there were actual individual blooms and petals in a garden. What a difference!

RDD: [Laughter]. Ok. So, you grew up in Linden, New Jersey, went to the local high school and graduated just before your 17th birthday. What were your favorite subjects?

Stu: Math was a strong suit and so was history. And I was an all-state debater in those days so I thought I'd become a lawyer.

RDD: You graduated at the top of your class? Or near the top?

Stu: Not particularly.

Jean: He's just being modest. Dad was an ace student and led his debate team to the New Jersey all-state championship. And as soon as he graduated from high school he started looking for a job. He wanted to train as a draftsman, but he failed the company aptitude test by drawing the test item in mirror image!

RDD: Ha. And so law was another interest. What veered you away from that noble profession?

Stu: Well. I took employment in the Prudential insurance company and they gave me a job as a tripper for the law department. So, I got to meet all these lawyers and carry their messages back and forth, and after a while I made up my mind that it wasn't really very interesting after all [laughs]. Nothing like experience. And so, I took a job at the Prudential, in the computing lab, in the IBM lab. Well actually what I did was to sort punch cards.

RDD: So, this was about 1941? And punch cards? These were the early Hollerith cards before computers?

Stu: That's right. There wasn't much. They didn't even have a multiplying punch. To take a sum of squares, you can just imagine what you had to do.

RDD: You graduated and let's see; you got a full-time job right out of high school?

Stu: Yes, I didn't go to college right away. I took the job at Prudential and started night school at Union Junior College in Cranford, NJ. I could walk to the night school from my house. By living at home with my parents I could just have dinner at home and then walk all the way up to school. So, I was working at the Prudential and taking night school—I was taking a math course, and a French course [laughter].

RDD: How did that work out for you? [Stu: laughter]. That must have been about the time of Pearl Harbor?

2. THE ARMY AND UNDERGRADUATE YEARS

Stu: Well yes, but before then, I left the Prudential working for the actuarial department. I left them to go to work for Esso at the Bayway (NJ) refinery where I could get back and forth to work very quickly just by taking a bus. I was working for Esso and going to junior college and then I left Esso and went full time at junior college for several months when I got caught up in the draft. Well actually, I enlisted, just a few months after Pearl Harbor. But because I was a student, they gave me another three or four months of schooling. Then they called me up in September of that year. So, September 1942, I was in the Army.

RDD: And what did they have you do in the Army?

Stu: Well, first they sent me to North Carolina State. That's where the Army Specialized Training Program (ASTP) was. But it was better known as "All Safe Till Peace," as we called it. And that's where I met R.L. Anderson who taught mathematics. I took Calculus from him. And then with my experience with punch cards they decided to assign me to the Aberdeen (Maryland) Proving Ground as an assistant, computing with Frank Grubbs. I was a GI [2] at Aberdeen for about six months or so. And then I got up on what was called a chronograph team and we were originally scheduled to go to Europe.

RDD: OK. I always wondered how NC State popped into the picture for a boy who grew up in Northern New

[2]Soldiers often referred to themselves as "GIs," the intials probably coming from the letters stamped on military equipment – G.I. for Government Issue.

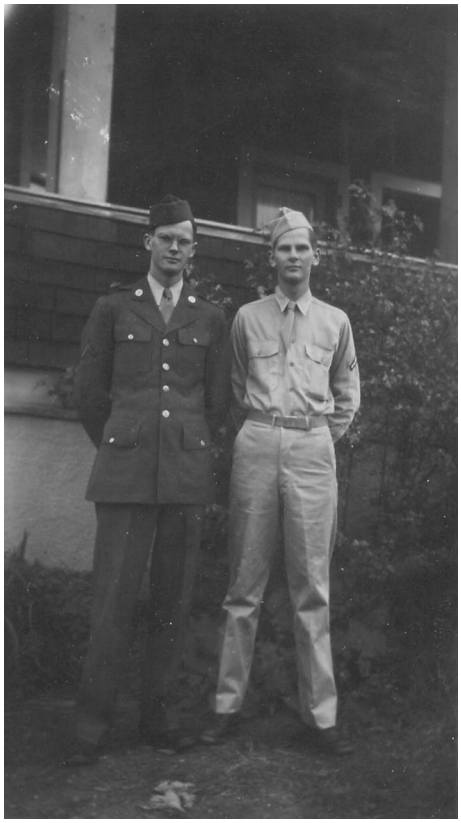

FIG. 2. *Stu (at left) in his uniform.*

Jersey. It seemed a mystery. Thanks for clearing that up. But, what is a chronograph team?

Stu: Well, the field artillery teams have very large equipment—huge cannons and things of that sort. And after they've fired a few rounds, they'd wear out the tube and they'd need a new firing table. The chronograph gives the field artillery a way to accurately measure the muzzle velocity of a weapon, and so helps to calibrate the weapon. So, our team went around to all those teams. Then, we were assigned to go to Europe to put this into action and we were in Boston, and everybody was ready to get on a flight and they canceled at the last minute and sent me to the Philippines. So, we did chronographs of the artillery all over the Philippines. Every big island in the Philippines, I've been there.

RDD: Wow. And how long were you there?

Stu: Until the end of the war. A couple of years and I was there when the war ended.

RDD: So, what was it like day to day?

Stu: Well, we had the Japanese surrounding us in what was a sort of gentleman's agreement where they could have the roads at night and we had them in the daytime. They would raid our kitchens, and even the garbage because they were starving. The trouble was that they weren't getting any food. But I was only fired on in anger once. Other times it was friendly fire.

RDD: But, you survived...

FIG. 3. *Stu as a young man.*

Stu: Yes, and, eventually the war's over and thousands of GIs are stuck in the Philippines, waiting for transport ships to take us home. At that point the Army began classes for those troops to keep them busy and out of trouble. I taught several math classes in Manila at the Philippine Institute for the Armed Forces. I realized I enjoyed it and had a knack for it. They discharged me in 1946, but at end of the war they needed people to help teach the floods of GIs coming back, so, that's why I went back to NC State. I taught courses in beginning math and so forth to all these returning GIs. I was talking about algebra, trigonometry and stuff like that. So that they could pass their tests.

RDD: And you'd taken math there before the war.

Stu: That's right. R.L. Anderson, who taught mathematics also taught statistics and so I came back to NC State principally to take mathematics, to get a degree in engineering, electrical engineering, and get a master's degree in math. That was my objective. So, I was sent there by the army before the war and returned there on my own. And one thing leads to another you see.

3. GRADUATE SCHOOL, EARLY CAREER, MARRIAGE, BOX, TUKEY AND PRINCETON

RDD: Okay. So, now you have your master's degree in math?

Stu: Yes. And then I ran into Gertrude Cox, and she hired me to help run the computing laboratory because they had some IBM equipment. I then spent two years in charge of the computing laboratory and I also was in charge of phalanxes of women who did the computations on calculators.

RDD: What they used to call a "computer" right? I mean that there was room full of women who did these calculations during the war.

FIG. 4. *Stu with Tady about* 1990.

Stu: Right, and then the IBM equipment began to take over. And so I got to use the first multiplying punch put out by IBM. So, we learned how to do all that multiplication in a hurry that way. I had spent two years in that job and then I said to myself, "you know, hell, I've spent a lot of time working on everybody else's PhD thesis. So, maybe I'll do one myself." And so Gertrude Cox arranged for me to get an assistantship. So, by 1950 I had worked for Cox a while and I'd saved up a good deal of money and I had to make up my mind whether I would ask this girl [Edna Martz (Tady)—the future Mrs. Hunter] to marry me, or take a trip to Europe instead.

RDD: Wow, what a choice.

Stu: And so I took my trip to Europe and when I came back from that—it's now 1952—I remember that Tady was very cold to me when I got back (laughter).

RDD: And where did you meet?

Stu: Oh, we met at the boarding house where we ate our evening meals in Raleigh (North Carolina). At around six o'clock she'd show up. She'd walk in and there were tables, four or five tables, with about six or eight of us at a table. Well one night, everyone at our table were "Yankees" and she was from Pennsylvania. So that's how we met. And so, in 1952 I asked her to marry me. She agreed. And then in 1953, George Box shows up at the Institute of Statistics for a year as a visiting professor and Gertrude Cox assigns me to him. I did my PhD, or more accurately, George Box did my PhD [laughter] on rotatable design. I thanked him. I thanked this gentleman for his genius and generosity. And I meant that quite sincerely.

RDD: And so, was George Box actually an academic at that time or was he still working as an industrial statistician for ICI?

Stu: Oh yes, he was a visiting professor at NC State for a year in 1953. That's when Gertrude [Cox] assigned me to him. And we got started looking at fractional factorial designs. Then in '54 I get the degree and in '55 Jean arrives. Is that right? [laughter]

Jean: That's right.

Stu: Okay. All right. I took a job at American Cyanamid right here (points outside the car) as a statistician. That's here! (excitedly points outside again). We lived in North Bergen (NJ) and then later on we moved to Plainfield (NJ).

RDD: So, it's 1954 and you're working as a statistician for American Cyanamid. It seems like that's the end of the story with George Box. But how did George pop back into picture?

Stu: That's a good question. While at Cyanamid I started teaching night school. George Box gets a job at Princeton. I'm living in Plainfield and he's in Princeton. And so, for a while I commuted to see him, but eventually gave that up. We moved to Princeton.

RDD: So, he offered you a job?

Stu: Oh yes.

RDD: When you say he had a job in Princeton, what was the job? There was no Statistics Department yet, so, where was he? Not in the math department I'd guess. Was there a center?

Stu: Yes, George was running the statistical techniques research group in collaboration with John Tukey and Sam Wilks.

RDD: Ah. So, Tukey and Wilks had some kind of soft money that they used and hired George to run a center?

Stu: Yes. Tukey always got money and so did Sam Wilks who was highly regarded. There was the Math Department and Tukey was there and Wilks was there, but not George. He was at the research center which was on Nassau Street in the Gauss House. It was great. All sorts of interesting people showed up. And I was sort of Sam Wilks protégé. We'd taught a course together—Stat 512. And a funny thing is that he'd write up the examination papers, you know, the exam questions and then we'd get together to grade them. And uh, my students always did better [laughs].

RDD: Your students did better? I'm shocked—completely shocked. [laughter] That's great.

Stu: Sam was a good guy; he befriended me many times.

RDD: And what kind of problems were you working on?

Stu: All sorts of things. Experimental design. And time series analysis. Serious stuff. George ran the center.

RDD: OK. So, you'd done your PhD thesis on rotatable designs with George and you'd published a paper with George on Multi-factor Experimental Designs [2] and a paper on confidence regions for experimental designs [1] before you left NC State. And with Youden [W. J. Youden], you'd written a paper on Latin squares [7].

Stu: Yes, those were all while I was at the Institute of Statistics at NC State before I got my PhD. George first started working on fractional factorial designs at NC State.

RDD: Well before that, Fisher [Sir Ronald A. Fisher] had developed the factorial design and the analysis of variance that went along with that. So, what you and George were working on was, in some sense, supersaturating those designs to get more factors into fewer runs?

Stu: Yes, well the trick was what happened when you did this? And the danger, or the challenge, was that the assumption of the linear model had to be adjusted to take into account interaction and quadratic effects. And nonlinear—all the nonlinear aspects of the situation. So, when you want to run many factors, the trick is to figure out what you want to leave confounded and not confounded. And then what sort of confounding arrangements are acceptable? It takes lots of cutting and thrusting to get the best patterns.

RDD: There was a lot of really cool algebra in there too. I always loved writing the generating pattern 12=34 on the board and then leaving it for the next class to figure out what the heck this guy meant [laughter]. The algebra of factorial designs is actually quite deep, especially Latin squares.

Stu: Yes. Beware the Latin square! [laughter]

RDD: For your papers with George (Multi-factor Experimental Designs for Exploring Response Surfaces [3] and the $2^{(k-p)}$ Fractional Factorial Designs, Parts I and II [3, 4] what was the main impetus?

Stu: We had found that these designs were incredibly useful in industry and wanted to lay out the theoretical implications and get all the results down in a few papers.

RDD: Right, and those papers were fundamental. I see nearly 1000 citations for the factorial design papers and almost twice that for the response surface paper.

4. BOX AND FISHER

RDD: So, at the Princeton center, where did the problems come from? Were they motivated more by methodology or motivated by science?

Stu: They were motivated by George Box [laughter].

RDD: Well what was George motivated by besides cranking out papers.

Stu: I mean that's it. That was it. He just wanted it. He was an alert mind and just wanting to push it. As you know, he was a student of Fisher. And so, Fisher came to visit us a couple of times. And in addition, back at the NC State Institute, I drove Fisher back and forth from NC state, to UNC Chapel Hill (University of North Carolina at Chapel Hill), because he'd have something to do in Chapel Hill and I would drive him over and back.

RDD: I heard he could be rather—what's the word—critical.

Stu: Well, Fisher was always nice to me. And he very much appreciated George. And, of course, that's what happened. Joan Fisher [daughter of R. A. Fisher] came over with her father, and George offered her a job as secretary of our statistical research center. So, Fisher goes back and forth and leaves Joan behind. And one thing led to another—Joan begins to work on George and George begins to work on Joan and then before you know it, he divorces his wife, Jessie. And my wife, Tady, was good friends with Jessie and so Tady of course had her loyalty to Jessie.

RDD: Oh. I've met Claire several times, who I thought was his second wife, but it turns out she was his third.

Stu: Right! So, after the Center, when George went out to Wisconsin (University of Wisconsin, Madison) to establish a department. I went out there too, as a "Statistician in Residence" I was ready to become a professor in their department but Tady's loyalty to Jessie made that a problem, and so I went back to Princeton.

RDD: And why exactly did George leave Princeton?

Stu: Oh, because of the divorce. When he married Joan, they decided that some fresh territory would be a better thing. So off he goes to Wisconsin.

5. PRINCETON AND CIVIL ENGINEERING

RDD: OK. So, you came back to Princeton and joined Chemical Engineering as a statistician, because Engineering didn't have anyone to teach statistics?

Stu: That's right.

RDD: What a strange story, this story is—and this story of Statistics at Princeton continued for the next 50 years. So now, what position did they offer you?

Stu: Well, I started as an Assistant Professor, but one reason I went out to Wisconsin again in 1967 was because Chemical Engineering was not going to promote me to Professor because I wasn't a chemical engineer. I could stay Associate Professor at Princeton as long as I wanted to, but I thought, "well, I want to be a Professor!" So John (Tukey) came out to Wisconsin in 1968 to invite me to come back and be a Professor in Civil Engineering.

Jean Hunter: Didn't Norm Sollenberger (chair of Civil Engineering) tell you not to sell your house before you left?

Stu. Yes. Yes, he did! Definitely. That's true. Yes, you're right. He knew I was going back to Wisconsin and he said "don't sell your house."

RDD: So, that was 1968. What good fortune for me, because it was just two years later, in the fall of 1970 that I took Civil 218 (Introductory Statistics). Because otherwise you wouldn't have been there and God only knows what I would have wound up as. So, now you're in Civil Engineering and you had these courses that were

getting top ratings in the university bypassing History and all sorts of other courses.

Stu: Oh, yes [laughing]. Almost every year I was in the top ten and in fact, one year I had two courses in the top five. I got a note from the Dean of the College who was quite surprised.

6. CONSULTING AND SHORT COURSES

RDD: So meanwhile, during all of this, Tukey is in the Statistics Department and you're the lone ranger in Engineering and the Statistics Department is sort of growing in its modest way, split off from math. And they got Geoff Watson to come in from Johns Hopkins (University) and be the chair. And then you stayed there in Civil Engineering until you decided to retire because you had this other life. You were you doing all these short courses and you were so popular with these and your consulting.

Stu: I was making a fortune.

RDD: Many young statisticians ask me for advice about how to start up a consulting career and it's a hard question to answer, because it's tough to get started as an industrial statistical consultant if you're an academic. But it helps to have a mentor who has too much work! I remember one day, when I was an assistant professor at Princeton, you walked into my office and showed me your agenda. Monday through Friday had Ford in big letters written on each page but Alcoa was also written on Wednesday, Thursday and Friday. You looked at me and said, "Dick, I can't be in both places at once. Which one do you want?" That really kickstarted my consulting career. You introduced me to the Alcoa group, who, I have to say, were pretty leery of some young buck replacing, or even helping, Stu Hunter with these short courses, but you eased me in. We taught those together for almost 10 years and eventually I got to take them over. I've always wanted to thank you for that.

Ok, so you did all these incredibly popular short courses for industry. Luckily, we have some of those tapes that you did at Westinghouse. They're now on YouTube and it's wonderful (e.g., https://www.youtube.com/watch?v=NoVlRAq0Uxs&list=PLgjnRjSuvqgdT6D1ujfIKonxHMXkfvDLF). But I have to ask you about one. There's one where you start with an accountant's eyeshade on your head and you start by saying "You know if you ask the average person what a statistician does, they'll eventually reply—Well, he's a number librarian." And you talk a while, but then you get up and you take off your sweater and you put it on a hook. And I know who you stole that from. That gesture. It's the same one that Fred Rogers (Mr. Rogers) used to do on every show. So, you stole one of his great gestures. I love that. I watched that and I just, my mouth dropped. I realized that you were a great student of theater.

FIG. 5. *Stu with Dick De Veaux (interviewer) at a San Francisco Giant's baseball game.*

FIG. 6. *Westinghouse short course on Design of Experiments.*

Stu: Yes, actually I shared a television studio with Fred, so I guess I did [laughter]. He once let me pull the string for the train at the end of the show. That was a highlight.

RDD: You also had some theatrical moments in your classes that I remember. Every time you wanted to introduce a new kind of data, or a new method in your lectures you'd say, "The door opens and this guy walks in and says 'Stu! I have these data.' " And you'd proceed to show how these data motivated the method. But one day, when you did this, one of our classmates who had been waiting for you to say that burst through the door with a lab coat and clip board and said "Stu! I have these data" And you turned around and you just stared at him for what seemed like an eternity—I've only seen you speechless a couple of times.

Stu: Oh my yes, that was quite a moment.

RDD: And that just reminded me of a time when you left my date speechless. One of the reasons you were such a successful teacher is that you were human. You were approachable and had a sense of humor. I can't say that about all my professors. This time you were riding your bicycle on campus and came upon me and my date walking and you stopped on a dime, looked at both of us, pointed to me and said to her, "Watch out! That's a high energy particle you've got there" and sped off.

Stu: [Laughter]. I did? And what happened?

RDD: Well, we're no longer together [laughter]. Ok, so a few years after that you're consulting so much that you

realize you can't keep teaching full time and you had a discussion with the Dean I believe.

Stu: Oh, that's right. I went to the Dean and I said, I'd really like to go half time because I'm so involved off-campus. And he said, "At Princeton we don't have half-time professors. Either you are full time or you retire." And I said, "But John Tukey is half time here and half-time at Bell Labs." He paused and then said, "Stu, you're no John Tukey!."

RDD: Right! Who is? So after "retirement" you were more active than ever.

Stu: I did a lot of traveling, lots of traveling. Let's see. I gave courses in South Africa, Australia, Japan, New Zealand, Argentina, Sweden, and Korea and China! We were some of the first Americans to visit China after Nixon opened it up. I often had to travel alone, but sometimes Tady and the children would come with me. Tady and I went to Dalian, China for two summers. Tady was the first Western woman that many of the Chinese had ever seen, so that caused quite a stir.

RDD: Yes, I saw you at every conference for years and especially at The Gordon Conference, and you know that was a real mentoring moment for me. Back in the early 80s you asked me if I'd even been to the Gordon Conference and when I said no, you said "Oh, we'll have to fix that." And your getting me there—that really changed my life.

Stu: Really? How.

RDD: Well it really got me involved in that community. I had just gotten back into Statistics after the several years I took off to dance professionally. [3] I was still at Penn (University of Pennsylvana), before I went to Princeton and I went to John Tukey's retirement celebration lecture, his "Sunset Salvo" lecture. I saw you and I hadn't seen you in years at that point. And I ran up to you and I said, "Professor Hunter, I just want you to know you're the reason I'm in statistics" And without missing a beat, you said "Dick, that's a burden I will carry to my grave." [laughter]

You mentioned pulling weeds when you were a teenager in Linden and there's another story I'd like to ask you about and that's John Tukey and gardening.

Stu: Oh yes, he would invite me to his house to garden.

RDD: Did you work on many problems with John?

Stu: Not particularly. He was just a very friendly professor who always watched over me, but often I'd talk to him and he'd say something profound.

RDD: My experience was that it often wasn't particularly clear what that particular sentence had to do with the problem right away, but you knew there was something deep there if you thought about it. In fact, I remember something you said about John and the Oracle at Delphi.

Stu: Ha. Yes, that's it. Talking with John was like asking the Oracle a question. You knew it was important, and you knew you could only ask one question and even though you had no idea what it meant right then, you'd just have to think about it for a few months. But John would invite me over to pull weeds and we'd talk. He had a very big lawn in his new house and we'd go out to clear out the dandelions. You can spend a good couple of hours talking to John Tukey, both of us on our knees, pulling dandelions!

RDD: But wasn't there a patch of another kind of weed that got you into trouble one time?

Stu: Oh yes, I remember that! Poison ivy! Oh, I got a bad case of poison ivy. I remember that well now.

RDD: Apparently you don't recognize poison ivy when you see it.

Stu: Oh, I got quite a case of it.

7. THE PROFESSION, ASA AND HONORS

RDD: Let me switch a little, ask about your relationship with the ASA. You did many things with the ASA. Of course, I know about your term as president, but tell me of other activities in the ASA.

Stu: I helped establish SPES [the Section on Physical and Engineering Sciences—founded in 1954].

RDD: Back then, in the early 50s, there weren't many sections.

Stu: That's correct. Now there seem to be new ones all the time. At that time, they were just a few. There was probably the Survey Section, the Government Section, the Biopharm Section and then Gertrude Cox established the Biometrics Section. So, we decided to have one that dealt with data that were physical in nature and so we created SPES. And that led to the launching of the journal *Technometrics* (in 1958). And do you know we [*Technometrics* are in our 60th year. Can you believe that?

RDD: I love going back to those first few issues and looking at the papers in there with you and Tukey and George, among others. It's wonderful.

Stu: And Fisher! You know he named it.

RDD: I didn't! I knew you were the founding editor, but didn't know where the name came from. And during your term as President (of the ASA), what was the thing you were most proud of?

Stu: It was probably certification. I initiated the drive to establish certification for statisticians.

RDD: And, all your awards. You've received the Shewhart Medal, the S. S. Wilks Medal, the Deming Medal, the ASA's Founders Award, and the Youden, Ellis Ott and Brumbaugh awards from the ASQ (American Society for Quality). When you think back on your career, what are you most fond of?

Stu: Oh, one thing I really enjoyed was lecturing for Westinghouse and doing those lectures—those tapes.

[3] https://magazine.amstat.org/blog/2015/02/01/de_veaux_balancing/.

FIG. 7. *Stu, Bill Hunter and George Box singing at the Gordon Conference (early 80s).*

RDD: And, I have to ask, what about your famous book, Box, Hunter and Hunter [6] which came out in a second edition [5] not too long ago. Can you tell me a little about what it was like to work with George?

Stu: Well, he was obviously the leader and the originator. And so, my principal role with George was to take the notes that we had given in all those short courses, so that we could put it together as text. And so, I'd put it together as text and then he would redo it. Bill Hunter was an undergrad in Princeton in 1959 and he was a great help in getting those mimeo copies together. When Bill later went to Wisconsin to get his PhD [he was the first graduate student in the new department] he became a natural added author.

RDD: Yes, I remember those early notes from your experimental design class in 1971 at Princeton. I looked up recently and found that BHH had over 15,000 citations (!) and that doesn't even take into account the impact that it had for industrial statisticians around the world. One thing that's great about BHH is that the second edition came out—how many years after? The first one was published in 1978. And the second one came out in 2005, 27 years later.

Stu: Oh! What? that doesn't seem possible.

RDD: I'm afraid that's right.

Stu: That's incredible! That can't be right. I am really surprised.

RDD: It probably seemed like it was only a couple of years.

Stu: Yes! That's right! [laughter]

RDD: That's great. I love it. I love it. Actually, that drives editors crazy, doesn't it? To the authors it seemed like it was just a couple of years and it was actually 27. You probably said "Oh, don't worry. We'll get it in soon."

Stu: [still incredulous] I'm going to look both of those up. [Editor—I did. 1978 and 2005.] I can't believe that. Over 25 years. Good gracious!

FIG. 8. *Stu at the JMP Discovery Conference.*

8. PARTING THOUGHTS

RDD: Stu, this has been great. I've really enjoyed it. Now, I know you're passionate about many things. I remember when I started getting into data mining after leaving the world of experimental design and you nearly disowned me [laughter from Stu and Jean].

Stu: Yes, I was warning about PARC analysis [Practical Accumulated Records Comparisons].

RDD: That's right. You said when you have happenstance data and just built models on it you could wind up with what PARC spells backward. So, what advice would you give to a young statistician in this world of machine learning and Big Data and Data Science?

Stu: Well, I think that's good. It's important work—trying to find structure in the data but, the advice I'd give is that they should always report the results with their standard error.

RDD: Well, that is a challenge.

Stu: They should always mention the noise. And when I was giving those lectures at Westinghouse, one concern

FIG. 9. *Stu at the beach (recent photo).*

was always the auto-correlation of the data—the time dependence of the data that machine learning doesn't always account for. And often the data that you find isn't representative of anything—it's chock full of emptiness.

RDD: Wow. Chock full of emptiness. I've got to use that.

Stu: The essential art is to find the structure in the data after taking into account how the data depend on time.

RDD: Thinking back to you and PARC analysis, one thing that I often emphasize is that the result of these machine learning techniques on happenstance data are hypothesis generators, not hypothesis confirmation.

Stu: Yes, yes. That's very good [laughter]. I like that. And to get to confirmation you need experimental design. But I'd like to emphasize not to forget the importance of the noise and that you should always estimate the standard deviation. Get the standard deviation estimated and see if there is any structure left. Fit a deterministic model and the stuff left over should be without structure. And make sure that what you're doing actually solves the problem that the scientist wanted to solve in the first place.

RDD: Well Stu, it's been a real pleasure catching up with you. Any last words for the young statisticians?

Stu: I'd certainly tell them to go for it! It's a wonderful field, and it's very, very broad—it's been a wonderful place for me to be all these years. And—be of good cheer!

ACKNOWLEDGMENTS

I would like to thank Jean B. Hunter, not only for driving us from Newark Airport to Princeton while I interviewed Stu, but for feedback on several drafts, corrections and additions and invaluable other assistance on this project.

REFERENCES

[1] BOX, G. E. P. and HUNTER, J. S. (1954). A confidence region for the solution of a set of simultaneous equations with an application to experimental design. *Biometrika* **41** 190–199. MR0062388 https://doi.org/10.1093/biomet/41.1-2.190

[2] BOX, G. E. P. and HUNTER, J. S. (1957). Multi-factor experimental designs for exploring response surfaces. *Ann. Math. Stat.* **28** 195–241. MR0085679 https://doi.org/10.1214/aoms/1177707047

[3] BOX, G. E. P. and HUNTER, J. S. (1961). The 2^{k-p} fractional factorial designs. Part I. *Technometrics* **3** 311–351. MR0131937 https://doi.org/10.2307/1266725

[4] BOX, G. E. P. and HUNTER, J. S. (1961). The 2^{k-p} fractional factorial designs. Part II. *Technometrics* **3** 449–458. MR0131938 https://doi.org/10.1080/00401706.1961.10489967

[5] BOX, G. E. P., HUNTER, J. S. and HUNTER, W. G. (2005). *Statistics for Experimenters*: *Design*, *Innovation*, *and Discovery*, 2nd ed. *Wiley Series in Probability and Statistics*. Wiley, Hoboken, NJ. MR2140250

[6] BOX, G. E. P., HUNTER, W. G. and HUNTER, J. S. (1978). *Statistics for Experimenters*: *An Introduction to Design*, *Data Analysis*, *and Model Building*. *Wiley Series in Probability and Mathematical Statistics*. Wiley, New York. MR0483116

[7] YOUDEN, W. J. and HUNTER, J. S. (1955). Partially replicated Latin squares. *Biometrics* **11** 399–405.